

Autonomous Cell Culture Apparatus for Growing 3-Dimensional Tissues in Microgravity

Problem Statement

- Currently, there are almost no methods by which researchers can grow 3-D human epithelial tissues in microgravity to study the multiple hazards that long duration spaceflight poses to human health. To better understand and mitigate these risks, we are developing equipment that can culture these 3-D models in zero-g and maintain the air-liquid interface they require for proper growth.
- This flight opportunity will help mature the technology by allowing us to test the equipment modifications and upgrades, with all subsystems, in a relevant zero-g environment.
- Potential users include life science investigators interested in conducting research on 3-D epithelial cultures (of lung, esophagus, oral cavities, colon as well as others) in microgravity

Technology Development Team

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- Funding:**
 - Yale University: Science & Engineering Assoc. (cerro@aya.yale.edu), Physics Dept. (meg.urry@yale.edu), Science Council (william.segraves@yale.edu), Dean's Office
 - Connecticut Space Grant Consortium (ctspgrant@hartford.edu)

Proposed Flight Experiment

Experiment Readiness:

- April 2012

Test Vehicles:

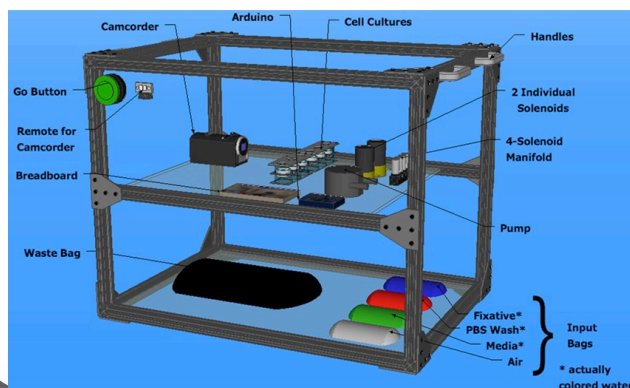
- Parabolic aircraft for initial testing
- SRLVs for higher level testing to mature the technology

Test Environment:

- 2010 – Flown on parabolic aircraft in April 2012 through RGSFOP SEED program
- 2012 – Scheduled to fly May 2012 on parabolic aircraft through NASA FOP

Test Apparatus Description:

- The cell culture compartments consist of 6 removable mesh inserts placed into a well-plate array of 6 separate compartments, with an upper and a lower chamber that air and liquid can flow through. A peristaltic pump and solenoid valves act to create an air-liquid interface over the cell culture within the mesh insert. All hardware, including a video camera for data collection, is enclosed within an 80/20 box with Plexiglas paneling.



Technology Maturation

- The current TRL of our project is level 4/5. To bring the TRL solidly to level 5, the device must be capable of air and liquid transfer within the two chambers of the cell culture compartment. It must also function autonomously.
- This equipment is designed for use in life sciences experiments; therefore, the final test of its functionality will necessitate biological cultures to bring the TRL to level 6. This will require a "recycling" flight that will contain biological cultures and cell culture reagents.
- A final test on a sRLV platform, with one sustained period of microgravity, will verify the fidelity of the device and all subsystems.

Objective of Proposed Experiment

- To test and verify the functionality of a fully automated cell culture apparatus that maintains an air-liquid interface.
- Test functionality of the gas-permeable, liquid-impermeable membrane and whether the design of the cell culture compartment is adequate for air and liquid exchange with minimal bubble formation.
- Expected flight data will be from visual observations and video camera recordings

Applicable Technology Areas: OCT Technology Area 06 – Human Health, Life Support, and Habitation Systems (TA06, HLHS).